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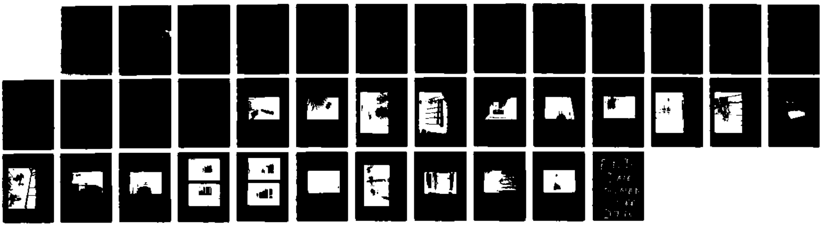

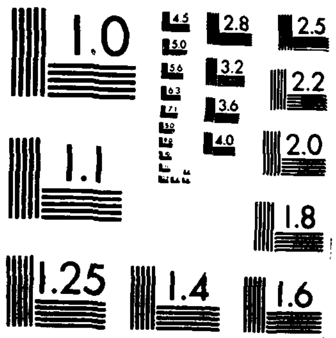
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The Center for Basic Research in Radiation Bioeffects is a unique facility allowing for simultaneous exposures of biological materials to two different types of radiation simultaneously (or suquentially), these being radiofrequency radiation (RFR) in the microwave range and X-rays (ionizing radiation), or RFR and ultraviolent light. The chamber is unique in that it is both temperature and humidity controlled, allowing for its use as a 37 dégree C warm room for in vitro experiments, or as a temperature controlled room with different humidities for in vivo exposure studies. The chamber is equipped with a low light level color camera for continuous monitoring of the exposure and control samples. A BSD-200 thermometry system with non-interactive Vitek probes allows for continuous temperature monitoring (8 probes). A custom designed transmitter purchased for the facility will allow RFR exposures at 915 MHz or 2.45 GHz, CW or PW, with or without amplitude modulation. The peak pulsed power will be 5 KW, with a maximum average power of 400 W.

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CENTER FOR BASIC RESEARCH IN RADIATION BIOEFFECTS

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CENTER FOR BASIC RESEARCH IN RADIATION BIOEFFECTS

I. INTRODUCTION

The opportunity for university located biomedical research scientists to investigate the health hazards associated with radiofrequency radiation (RFR) exposure has been limited by the absence of the necessary exposure facilities at their institutions, in close proximity to the laboratories where biological systems are maintained. To eliminate this difficulty, and as a means of encouraging greater participation by physicians and biomedical researchers in answering the numerous questions which have been, are being, or will be raised as to possible adverse health effects of non-ionizing RFR, a unique facility has been designed and constructed in the Department of Radiology at the University of Texas Health Science Center at San Antonio (UTHSCSA); it is the "Center for Basic Research in Radiation Bioeffects (CBRRB)". The funding for the construction and equipping of the CBRRB came from two sources; one was the Department of Defense (U.S. Air Force) University Research Instrumentation Program ($299,849.00) (AFOSR-87-0029), and the second was the Permanent University Fund (PUF) of the University of Texas ($173,000.00). The complete facility, jointly funded by the DOD and the PUF Funds, is additionally unique in that it will allow for biological experimentation involving simultaneous RFR and X-ray (ionizing radiation) exposures, or RFR and ultraviolet light (UV) exposures. All exposures would be performed in the specially designed anechoic chamber, which is both temperature and humidity controlled. Keywords: laboratories; → cont'd in DD1473

II. FACILITY DESIGN AND CONSTRUCTION

A. THE ORIGINAL FACILITY (prior to Center construction)

The original room in which the anechoic chamber was installed was designed for exposure of biological samples to X-rays produced by a Maxitron Orthovoltage X-ray unit. The dimensions of the room were 18 ft., 2 in. wide x 13 ft., 2 1/2 in. deep x 13 ft., 5 in. high (to the concrete ceiling beams). The adjoining control room, between the X-ray room and the adjoining hallway, measured 18 ft., 2 in. wide x 9 ft., 6 in. deep x 13 ft., 5 in. high (with a standard acoustical drop ceiling). A door was centered in the long wall between the X-ray room and the control room; this door was lined with 1/16 in. lead to a height of 7 ft., and opened outward into the control room. A safety interlock on the door provided for automatic cut-off of the X-ray beam if the door was opened during an exposure. A door centered in the long wall of the control room opened inward from the adjoining hallway. Lead shielding, 1/16th in. thick, had been installed in the wall perimeter of the X-ray room during its original construction, extending upward from the floor to a height of 7 ft. Since this was insufficient shielding for operation of a therapy type X-ray unit at 250 KV, 20 mA, additional lead panels, 4 ft. wide and 7 ft. high, of 1/8 in. thickness, had been bolted to the right sidewall of the room; additional 4 ft. wide panels, extending 6 ft. out into the room, had been installed on the floor from the base of the sidewall panel, and suspended parallel to the floor at the top of the 7 ft. panel. The room was serviced with standard house air conditioning and electrical connections. The power and water supply for the X-ray unit came from electrical equipment and a water pump located in the chaseway behind the rear long wall of the X-ray room.

As a first phase in the construction process, both rooms were completely stripped; all air conditioning ducts and vents, light fixtures, electrical conduits, etc., were removed from both rooms. After initial safety testing of newly installed lead shielding (described below), the X-ray unit, its supporting track, and the control panel were also removed. In addition, both door frames were removed.

B. CHAMBER CONCEPT

The concept of simultaneous exposure to RFR and X-rays required a configuration where the head of the X-ray unit would be lowered as close to the floor as possible, and turned so that the ionizing radiation would be broadcast in a vertically upward direction, while the RFR would be broadcast in a vertically downward direction from an antenna horn located as close to the ceiling as possible. The placement of RFR absorbing material directly over the face of the X-ray head, but beneath the biological sample, would prevent the microwaves from reaching the metal of the X-ray unit and being reflected back upward towards the sample, while at the same time, not prevent the X-rays from traveling upward through the RFR absorbing material to reach the biological sample. The placement of the antenna horn as close to the ceiling as possible would allow for the biological sample to be as close to the far field for 2.45 GHz radiation as possible. To accomplish these goals, as will be described below, brass pipe extensions were mounted on a brass plate attached directly to the metal foil shielding on the ceiling; this was for holding the circulator and antenna horn. For placing the X-ray head as close to the floor as possible, an approximately 3 ft. x 6 ft. "valley" was left in the RFR absorbing floor; this valley extended back from the location of the face of the X-ray unit to a false wall built across the width of the anechoic chamber room (Figure 1). The metal rails and carrier of the X-ray head were all positioned behind this false wall, which was itself subsequently foil and Echosorb shielded; the false wall was located parallel to and 2 ft. 4 in. from the rear wall. The final configuration, with the X-ray head lowered to the floor, and the brass pipes (with extra cylindrical connections) penetrating through the Eccosorb on the ceiling where the circulator and antenna horn will be installed, are shown in Figures 1 and 2.

C. INSTALLATION OF ADDITIONAL LEAD SHIELDING

Because of the need to protect workers on the floors above and below against ionizing radiation exposure, additional 1/4 in. lead shielding laminated on 3/4 in. plywood was added to the floor, to the right sidewall extending up to the ceiling, and just below the concrete room ceiling (suspended by metal brackets and extending out over and parallel to the shielding on the floor). Upon testing of the exposures in laboratories on the floor above with this initial lead installed, and with the X-ray unit positioned 56 in. from the right sidewall and facing upward, the UTHSCSA Radiation Safety Officer determined that the lead shielding on the floor, sidewall and at the ceiling all needed to be extended further. The X-ray unit, its electrical and water connections, and the supporting metal track and frame were then removed and the additional 1/4 in. lead shielding installed. The final dimensions of the lead shielding on the floor and ceiling, extending out from the wall adjoining the control room and the right sidewall, were 10 ft. wide along the front wall and 10 ft. deep along the right sidewall. Lead shielding was also bolted upwards along the right sidewall to match the depth of the floor and ceiling shielding, extending from floor to ceiling shielding (13.5 ft.).

D. TEMPERATURE AND HUMIDITY CONTROL

Because both animal and *in vitro* studies can be affected by ambient temperature and room humidity, and because *in vitro* exposures are best controlled when performed in a 37°C environment, a completely independent air handling system was designed for the anechoic chamber. The house air handling system was redirected through an adjoining laboratory, an emergency fire system damper installed, (see below), and this was used to provide air to the control room.

The heating, cooling, and humidifying units of the independent air handling system for the anechoic chamber were installed in the utility chase behind the rear long wall of the chamber. Incoming air enters the room through two penetrations in the rear wall just below the suspended lead at the ceiling, and travels out across the room through ducts to two positions on the right and left sides near the front wall of the anechoic chamber. The ducts turn down to penetrate through the subsequently instilled RF shielded ceiling (Figure 3). The return air duct is installed in the rear long wall toward the right side, at a lower height but above the 7 ft. lead line in the wall (Figure 4). Return air can reach this return duct by passing through an opening in the false wall near the X-ray unit, or through a wire mesh opening in the left side of the false wall; this opening is covered with silver colored SPY-18 Eccosorb cones. The air for the chamber is temperature and humidity controlled by a three-step process. The air after having left the chamber is first cooled using 45 degree house chilled water pumped through the A/C unit in the chase; cooling is controlled by a remote thermostat operating a chilled water valve. The heating and reheating are then both accomplished through an electric heater in the discharge of the A/C unit, prior to passage through the humidifier. The latter is installed in the discharger of the A/C unit.

The heating and cooling are controlled by the same remote thermostat, which is located on the left sidewall of the control room (Figure 5). The humidity is controlled by a remote mounted humidistat also located in the control room. The temperature and humidity of the anechoic chamber system are monitored by probes inserted in the return air duct outside of the chamber (in the rear chase). Signal wires and a pneumatic tube travel outside of both the anechoic chamber and the control room to the front hallway, where they enter a specially constructed electrical cabinet (Figure 6) from above. The electrical lines pass from the hallway cabinet through special Fil-Coil electrical filters (Figure 6) into conduits installed on the electromagnetically shielded (metal foil lined) pre-existing wall of the control room, to the position of a controller mounted on the left inside plasterboard wall (final) of the control room (Figure 7). A pneumatic tube to the humidity controller penetrates through the front foil shielded wall above the cabinet (Figure 8) into the control room through a brass pipe installed near the concrete ceiling.

The above described system will be calibrated by actual air temperature measurements to be made with a BSD-200 thermometry system purchased for the CBRRB, so that any necessary correction can be made between the readings in the return air duct and the actual temperature measurements made in the air in the chamber. The above described system is unique for RFR anechoic chambers, in that the system can be operated as a 37°C warm room with low humidity, or alternatively at different but controlled temperature and humidity levels for animal studies.

As already indicated, the air to the control room is house air, rerouted through an adjoining laboratory. The air enters the control room on the right side through a HV-1 RF shielding honeycomb vent contiguous with the metal foil shielding on the inside of the pre-existing wall, and is taken by ducting to the center of the room where it turns downward through an acoustical drop ceiling. The return air vent is installed through the ceiling at the left rear (Figure 8), and leaves the facility above the shielded ceiling of the chamber to the rear chase.

E. HALON FIRE SUPPRESSION SYSTEM

To be able to isolate either room from the external environment in the event of a fire, and to keep the halon from the specially constructed fire suppression system inside the room with any fire, electrically controlled dampers have been installed in the air input and return lines of the air handling systems of both the control room and the anechoic chamber to close off the ducts and isolate the rooms in the event of a fire. A separate exhaust system has been installed in the left rear wall of the anechoic chamber (Figure 9), so that after the halon dumps and suppresses any fire, a hand switch in the electrical cabinet in the front hallway can be used to open a vent in the exhaust system and turn on a fan to the roof, thereby exhausting the anechoic chamber and allowing safe entry.

The halon system is automatically controlled by cross-zoned smoke detectors (two) in each room. The alarm system sounds both a local bell, and is also connected to a fire alarm monitoring system at the University Central Control Room. The system has a control box mounted in the right sidewall of the control room, above the sink (Figure 10). Abort switches are located inside the control room besides both doors (e.g. Figure 7); an operator can disable the halon dump for 60 sec after the alarm goes off by pressing the abort button, giving a short delay to check on the video camera or in the control room for visible signs of the fire before the halon dumps. The systems are supplied by two tanks mounted above the drop ceiling of the control room on the front and rear walls (on the right side). The Halon Fire Extinguishing System was installed and tested according to Factory Mutual Insurance Company requirements.

F. ELECTROMAGNETIC SHIELDING AND FINISHING OF THE CONTROL ROOM

After installation of the magnetic door frame in the long wall of the control room adjoining the front hallway, 2 x 3 in. furring (spaced at 16 in. O.C. [On Center) was placed around the room; to this was mounted 1/2 in. fire retardent treated (F.R.) plywood. Two x 3 in. sleepers were installed on the floor (spaced at 12 in.); 2 x 8 in. joists were mounted on a frame at the ceiling, and solid bridging was placed between the joists at one point across the room. One half in. plywood was then mounted for a floor and ceiling. WP-3-SS metal foil shielding, 3 mil thick, was then epoxy bonded to the plywood on the floor, walls and ceiling. Special Eccoshield PST-PA-4 in. tape (pressure sensitive) was used to overlap the WP-3-SS strips. During this stage in the construction process, metal conduits for any and all electrical and pneumatic lines were mounted against the metal foil on the inside of the control room (e.g. Figure 11), as were piping for the halon systems of the control room and the anechoic chamber, and mounting brackets for the two halon tanks. In addition, brass fittings were mounted in the control room right sidewall for penetrations for the sink, an RFR shielded penetration was mounted in the right sidewall of the room (near the ceiling) for penetration of the air system into the control room. Whenever screws penetrated through the metal foil to mount any connector to the wall, a special silver putty (Eccoshield VY) was used to insure electrical continuity. In addition, when metal filter boxes were mounted against the metal panels, the backs of the filter boxes were cleaned to the bare metal, and the flat surface was painted with a special conductive silver paint (Eccoshield ES).

After all of the room had been shielded, and all of the penetrations made and conduits mounted, a second false wall was built over the metal foil shielding. For the walls, 1 x 3 in. furring was epoxy bonded at 16 in. O.C. over the shielding, and covered with 1/2 in. gypsum wallboard. On the floor, 1/8 in. Masonite was bonded over the shielding, and a 1/8 in. vinyl composition tile was used to finish the floor. An acoustic drop ceiling was installed in the control room, at a height of 8 1/2 ft. above the floor, and extending back from the front wall to approximately 2 ft. from the rear wall. At this distance, the drop ceiling was raised to a height of approximately 10 1/2 ft., so that the top of the recess panels would be visible and accessible.

There were several special exceptions in the control room to the shielding just described. To the left of the outer control room door, facing inward from the hallway, a special electrical cabinet was constructed extending 2 ft. 4 in. out into the hallway (Figure 6). The cabinet was constructed of standard masonry, with a standard metal door with lock. The cabinet was 4 ft., 6 in. wide, 2 ft., 4 in. deep, and extends above 8 ft. high. The wall between the corridor and the control room was completely removed, and replaced with a "metal panel" constructed of 3/4 in. plywood with 26 gauge sheet metal laminated to both sides (Figure 6). This panel served as a mounting wall for the electrical filter boxes in the cabinet, and its reverse side was continuous with and connected to the metal foil lining on the inside of the control room (See Figure 11, lower right). Special electrical filters and a brass plate for BNC type connectors were mounted on this panel; a rectangular hole was cut in the metal sheet where the brass plate was mounted (Figure 6).

In the wall between the control room and the anechoic chamber, on both the left and right sides of the shielded door entering the chamber, similar metal panels measuring 5 ft. high x 3 ft. wide on the left side (Figure 12) and 1 ft., 10 in. high x 2 ft. 8 in. wide on the right side (Figure 13) were mounted above the 7 ft. line of the lead in the walls; these metal panels were also continuous with the metal foil lining the control room walls. This left recesses on the anechoic chamber side of the wall (Figures 14a and 15a); the recesses on the chamber side were enclosed with side by side swinging doors with bolts so that the closed doors were continuous with the inside chamber wall (Figures 14b and 15b). Special electrical filters (Fil-Coil) were mounted on the control room side of these metal panels with wires penetrating through the metal panels into junction boxes on the enclosed recess (chamber) side. Small brass plates were mounted in each of the recesses to allow penetration of BNC type connectors for the video camera and future equipment, and an additional brass plate was mounted in each of the panels for penetration of 5 brass tubes to be used for passage of plastic tubing for water and gas from the control room into the chamber. Also mounted through the metal panels were pin-type connectors in small plates for carrying signals between the "temperature box" of the BSD-200 thermometry system (mounted on a wall bracket on the anechoic chamber side (Figure 16)) and the computer of the BSD-200 system which will remain in the control room. Two other exceptions were smaller 14 in. x 14 in. brass plates. These plates had an array of nine connectors; the connectors are either for transmitting in the RFR energy via coaxial cables connected on each side, or carrying out forward and reflected signals from the circulator which will be mounted in the ceiling adjacent to the antenna horn. One of these transmitter connector plates was mounted on the right side, above the panel recess, at a control room height of approximately 10 1/2 ft. (at approximately 56 in. from the right side-wall), and the other was mounted on the left sidewall below the panel recess, at a control room height of approximately 6 ft. (Figure 12). On the control room side, wooden frames were constructed around the metal panels, but these were left open to the control room (Figure 12).

G. ELECTROMAGNETIC SHIELDING AND FINISHING OF THE ANECHOIC CHAMBER

After installation of the magnetic door frame in the long wall between the anechoic chamber and the control room, additional lead shielding was added around the door frame to prevent any X-ray leakage. The chamber ceiling was finished beneath the lead witn 2' x 8 in. joists spaced at 12 in. (running front to back), with four openings of 12 in. x 12 in. for light fixtures and two openings of 16 in. x 12 in. for inflow air ducts. Solid bridging was placed between the joists at two points across the room. The inflow air ducts penetrating the rear wall passed between the joists to positions 2 ft., 5 in. from the front wall of the anechoic chamber. The openings for the light fixtures were located approximately 4 ft. from the side walls, spaced around the final inner Eccosorb shielded chamber (Figure 3). F.R. plywood (1/2 in.) was mounted on the frame. The rear wall, left side wall and floor were furred out 2 in., using 2 x 3 in. vertical furring; the right sidewall was furred out 4 in., so that all protrusions from the mounting of the lead on the right sidewall would be evenly covered. F.R. Plywood was then mounted on the furring, and WP-3-SS foil was then epoxy bonded to the plywood of the ceiling, walls and floor. Masonite (1/8 in.) was then bonded over the shielding of the floor (Figure 3).

After this outer foil and floor covering was attached, the metal frame which carried the head of the X-ray unit was reinstalled (Figures 4,9). Additional wood blocking had been installed in the floor under the track, and against the right sidewall where the frame would be attached, prior to covering these areas with the plywood surface. The upper left corner of the metal frame was braced with a metal rod penetrating through the rear wall of the chamber. Silver putty was applied to all penetrations of the metal foil shielding. Penetrations for the water of the X-ray unit were installed in the right rear wall (Figure 17). In order to shield the metal frame from the microwaves, a false wall was then constructed at a distance of 2 ft., 4 1/2 in. from the existing foil shielded rear wall. Openings were left in this wall at the center to right side, in the form of a sideways L turned downward, so that the X-ray head could be moved up from the floor position and to the left in the direction of the center of the room (Figure 1). This would allow the option of X-ray only exposures in a horizontal (to the right only) direction. The frame of the false wall was covered with 1/2 in. plywood, and also with the WP-3-SS shielding, but no effort was made to make this shielding continuous with the floors and wall, since these were already shielded. A vertical access panel was also cut in the left side of this false wall (creating a door with hinge), so that the space behind it could be used for storage. As already described, another opening in the false wall to the left above the floor allowed return air to flow out to the return vent on the rear wall. Four detachable plywood panels were constructed for insertion in the spaces created by the open L; When installed, these cover most of the opening. The panels are covered with metal foil and echosorb.

H. INSTALLATION OF BRASS PLATES FOR CEILING MOUNTING OF CIRCULATOR AND ANTENNA HORN

In order to allow for several positions on the ceiling where an antenna horn could be mounted (with or without an associated circulator or bi-directional coupler), including over the X-ray unit head and at the center of the room, two 1/4 in. thick brass plates with hexagonal 6 in. extensions projecting downward were mounted (using bolts) on the metal shielding on the ceiling. One of the brass plates was large enough to hold a 3 x 3 array of nine 6 in. extensions, and was positioned with its center at 56 in. from the right sidewall, and its edge closest to the rear wall at a distance of about 5 ft. from the front wall. The hexagonal extensions were positioned at distances of 8 1/16 in. in one direction and 7 1/4 in. in another dimension (center to center; Figure 3). An additional and smaller plate for a 2 x 2 array of extensions, spaced at the same distances, was mounted on the metal shielding at the center of the finished chamber (Figure 3). In addition to these plates, several 2 in. x 2 in. brass plates, with individual 6 in. extensions, were mounted at positions in the ceiling off center from these plates, but surrounding the likely antenna horn position. These were for support of brackets to hold ultraviolet lamps (Figure 3).

All of the walls of this inner anechoic chamber, bounded by the front wall, sides, and ceiling, were then covered with Eccosorb. VHP-18 was epoxy bonded to the ceiling, and to the front and right side walls. VHP-12 was bonded to the left-side wall. VHP-18 was placed on the floor, and covered with Eccowalk. The latter was supported by legs of PVC piping, which were fitted and glued into upper and lower toilet flanges (Figure 18). These in turn were mounted to small 1 in. PVC squares using nylon bolts. The PVC squares were glued in place on the floor, and to the bottom of the eccowalk panels. The entire floor surface was covered with the eccowalk, except for the "valley" into which the X-ray unit was to be lowered. The height of the Eccowalk surface is 23 in. above the surface of the floor. Filler absorber (12 in. thick) was mounted on the inside of the magnetic (and lead) shielded door, and then VP-18 (beveled to allow for the door swing) was mounted on this (Figure 18). A step was placed inside the door to allow access to the floor surface. SPY-18 material was mounted in the ceiling over the air inflow vents, and also over the air return opening in the false wall. The halon nozzle in the chamber extended down through the metal foil-lined ceiling to the tips of the VP-18 cones at a central position in the room (Figure 3). Smoke detectors were located in the ceiling on the right and left sides between the air inflow ducts and the rear false wall. The metal foil and hinged access panels over the recesses between the control room and the anechoic chamber (Figures 14b and 15b) were also covered with the VP-18, but sections were mounted with Velcro strips, instead of being permanently glued to the wall. These sections can therefore be removed as necessary to allow access to the panels. For the light fixtures, four STONCO #150-L Lamp holders for 150W reflector spot lamps were installed in 11 3/4 sq. x 9 in. high Hi-Hat light fixture housings; these were inserted up into the 2 in. x 8 in.

ceiling framing.

As previously described for the control room, metal conduits were installed inside the metal foil shielding in the chamber along walls and the ceiling (Figures 3,9) to carry electrical wires for many purposes around the room. These included wires from the X-ray head to the filter recess on the left front wall of the chamber; from the distribution box in the recess to electrical outlets just above the Eccowalk floor on the left and right sides of the doorway and to the lights in the ceiling; from the pan and tilt motor and the zoom control of the camera mounted on a bracket above the door inside the chamber (Figure 19). The conduits along the rear chamber wall (behind the false wall) were left uncovered; all of the other conduits were covered with the Eccosorb which had impressions cut into it before bonding to the shielding.

I. ELECTRICAL CABLES AND CONDUCTORS

As already indicated, every effort was made in the design of this facility to insure the electromagnetic isolation of not only the control room from the anechoic chamber, but also both rooms of the facility from the surrounding environment. To accomplish this end, all wires entering the facility, or passing between the rooms, were either passed through individual oil-based electrical filters purchased from Fil-Coil, or through the appropriate BNC connector. Electrical power for the facility was brought into the facility via the specially constructed electrical cabinet in the front hallway adjacent to the magnetically shielded door. Several electrical filter boxes with over 40 individual filters, and a neutral ground filter, were installed on the metal plate at the rear of the cabinet (Figure 6). Wires penetrated from the filter boxes through the plate to either an electrical distribution panel or wire boxes on the inside of the control room (Figure 7). From the distribution panel, conduits installed inside the finished wall of the room, as described above, carried a) 208 V lines to the left and right sidewalls of the control room, for plugging in the specially designed transmitter; b) 208V to an additional receptacle on the right sidewall, for accessory equipment; c) 115 V lines to electrical outlets on the left and right sidewalls, for misc. equipment; d) 115 V lines dedicated to the control room lighting and the halon fire suppression system; e) electrical lines dedicated to the temperature and humidity controller; and f) 115 V electricity for the anechoic chamber to a filter mounted on the control room side of the recess to the left of the anechoic chamber door (Figure 12). After passing through these filters, the electricity went directly into a distribution box in the recess on the chamber side. In addition, control lines for the X-ray unit were brought around the facility from the rear power unit to the control panel inside the room via filters in the hallway cabinet and conduits in the wall. The telephone line was brought into the room via filter connections. In the control room, in addition to the above, conduits had been placed in the walls to carry the control and signal lines from a video camera monitor and controllers for a pan and tilt unit and a lens zoom to a filter box mounted on the control room side of the recess to the right side of the door leading into the chamber. Conduits also carried lines for automatic cutoff of the X-ray unit to a switch at the top of the chamber door; and from plug connections in right and left rear walls to a similar switch, for automatic cut-off of the RF transmitter if the door was opened. Conduits also carried lines from the switch in the control room to a filter box for turning power on/off to a receptacle on the chamber side for plugging in UV lights.

In addition to the 34 low amperage filters used for most of the X-ray unit electrical lines, four 5 amp filters were mounted on the right rear wall between the chase and the anechoic chamber to bring in power to the X-ray head from the transformer in the chase.

As already indicted, the electrical power lines were filtered between the control room and the chamber. In addition, the lines for the camera (6 for pan and tilt/ 6 for zoom control) went through individual filters between the rooms; the video signal penetrated through a BNC connector in the right panel. Electrical power for the COHU Model #1815-5100/Z10D color camera (solid state with 10-1, f 1.6, 11-110 mm lens), mounted above and inside the control room door (Figure 19), came from the distribution box inside the chamber. Conduits mounted against the metal shielding inside the room, but behind the eccosorb, carried electrical lines to the lights in the ceiling, and to 115 volt outlets mounted just above the floor on the right and left sides of the door inside the chamber. Detachable sections of Eccosorb were used to cover the outlets when not in use. Special pin connectors in metal plates, obtained from BSD, were mounted on the larger metal plate in the recesses on both the right and left sides of the cabinet. This allowed for the penetration of signals via a cable from the computer controller of the BSD-200 thermometry system kept in the control room, through the pin connector, and via another cable to the temperature box of the BSD which could be mounted on the front inside wall of the chamber, either on the right or the left of the door (Figure 16). Thus, the RF transmitter could be operated from either the right or left side of the control room, and the BSD-200 unit from the opposite side of the control room.

III. <u>ANCILLARY EQUIPMENT</u>

Under the joint sponsorship of the U.S. Air Force and Permanent University Fund of the University of Texas, an array of necessary and complementary instrumentation and equipment was purchased to make the Center operational, and to make its use multi-optional.

A. In addition to the Anechoic chamber and Transmitter (Control) Room described above, the equipment purchased for the chamber and included in the original Air Force Grant Proposal included:

1) Antenna horn and connectors: A standard gain antenna horn (Model 645) for 2.45 GHz RFR exposures was purchased from NARDA Corp. A separate coax to waveguide adaptor (Lieco L952) was purchased from Lectronic Research Laboratories (Figure 20).

2) Power monitoring equipment: A Model 438A digital, programmable power meter, with two 8481B power sensors, was purchased from Hewlett-Packard.

3) Field Measuring equipment: Two meters, a Model 8616 and a Model 8716 were purchased from NARDA. In addition, to measure electric and magnetic fields, five probes were purchased. These included: 1) a Model 8621D Electric Field Probe; 2) a Model 8623D Electric Field Probe; 3) a Model 8633 Magnetic Field Probe; 4) a Model 8652 Magnetic Field Probe; and 5) a Model 8741 Electric Field Probe. To expand the Em measuring capability of the CBRRB, a Holiday HI-3600 VDT Survey meter was also purchased.

4) RFR equipment: To allow for the use of the transmitter with circular or rectangular waveguides, a 4-channel poser splitter for use at 2.45 GHz was purchased from Microwave Control, Inc. This power splitter has four separate circulators, allowing for independent measurement in each channel of forward and reflected power, as well as insuring that no reflected power in any channel will interfere with the power distributed in any other channel.

5) UV lights and fixtures: Support plates were mounted in the chamber ceiling to hold brackets for UV lamps. In order to be able to quantitate ultraviolet fluences, UV meters were purchased from Spectronics Corp. for measurement of UV light in the UVA (Model #DM-365-N), UVB (Model #DM-300N), and UVC (Model #DM-254N) ranges.

6) Oscilliscope: Instead of purchasing an independent and free-standing oscilliscope, the transmitter design was modified to include an oscilliscope.

7) Construction of Horn stand: A non RFR interactive horn stand was constructed out of wood and installed with floor mounting (Figure 20) on the left side of the anechoic chamber. Six ft. dowels supporting the table-top at a height of 4 ft. above the Eccowalk floor of the chamber were inserted in flanges mounted on a wood pallet beneath the Eccosorb-18 on the floor beneath the Eccowalk; a wooden shelf was added at 3 ft. height to give added support. A bracket is being prepared for sideways mounting of the circulator and antenna mounting plate; this will allow for horizontal transmission of RFR across the chamber.

8) Replacement X-ray tube: The UTHSCSA administration purchased the new replacement X-ray tube from General Electric. Instead of just the tube, GE provided a complete replacement head. This will be stored in the chase behind the laboratory; by concurrence of both the GE staff and our own radiation physicists, the currently available and working head should be used until it expires.

9) Braun Bath/Circulators: To maximize the temperature control of water baths which would provide 0.1 degree C accuracy in convection heating, three Braun Thermomix Immersion Circulators were purchased.

10) Plexiglas water baths: The above described heater/circulators were installed in three specially constructed Plexiglas water baths; these measured 18 in. x 20 in. x 12 in. deep. Each bath has a fitted Plexiglas cover designed to open on one side and hold the heater/circulator on the other.

B. In addition to the above described equipment, a number of related items were also purchased with the joint funding for use with the Center. These items include:

1) Custom Designed Microwave Transmitter: A specially designed Radiofrequency Radiation Transmitter (Dual Frequency Source) was constructed for this facility by Microwave Control Co. Division, Micon Inc. The Model No. is S1222. The cost of the transmitter, and ferrite isolators with directional couplers for the specified frequencies of 915 MHz and 2.45 GHz, is $164,401.00. The projected delivery date of the transmitter is 15 July, 1988.

As already indicated, the transmitter will operate at the frequencies of either 915 MHz or 2.45 GHz, in either continuous wave (CW) or pulsed wave (PW) modes. The peak power will be 5000 Watts; the average power (CW or PW) will be 400 W. The shortest duty cycle achievable will be 0.08 at 5000 W. The pulse width will be variable from 1 microsecond to 10 microseconds; the power will be monitorable from either internal or external circulators with dual direction couplers via power meters on the front panel of the transmitter. The design also allows for amplitude modulation (AM) of the RF signal; this will be pre-set at 90%, and is available in either the CW or PW modes. The transmitter also includes a built-in oscilliscope, a frequency counter, and a PRF modulation counter. Two 25 ft. solid shield flexible RF cable are also provided.

This transmitter is unique in that questions as to the requirement for modulation of a signal at a given frequency, in order to see a bioeffect, can be examined.

2) BSD-200 Thermometry System: In order to measure the RFR induced temperature increases in biological specimens, and to determine the specific absorption rates (SARs) responsible for those temperature increases, a BSD-200 Thermometry system was purchased for the facility. This unit, which cost $27,000.00, employs non-interactive Vitek probes. Eight temperature measurements can be made and recorded at any time.

3) FACS-420 Cell Sorter: During the construction of the facility, another department made available, for a total purchase price of $5000.00, and installation costs of approximately $2,400.00, a four year old FACS-420 Fluorescence Activated Cell Sorter. The purchase price was originally in the range of $100,000., and the instrument had received an upgrade costing $30,000.00. Two weeks prior to our receiving the instrument, the laser failed, and a brand-new laser, costing approximately $11,000.00, was installed at no cost to our facility.

4) Additional equipment items, purchased for immediate use with experiments to be performed in the CBRRB, include a stereozoom microscope for counting colonies, a shaker water bath, a liquid nitrogen dewar for frozen cell storage, and IBM Compatible Computer, and a refrigerated bath/circulator to be used for reducing medium temperatures which would otherwise increase due to RFR exposure.

FIGURES

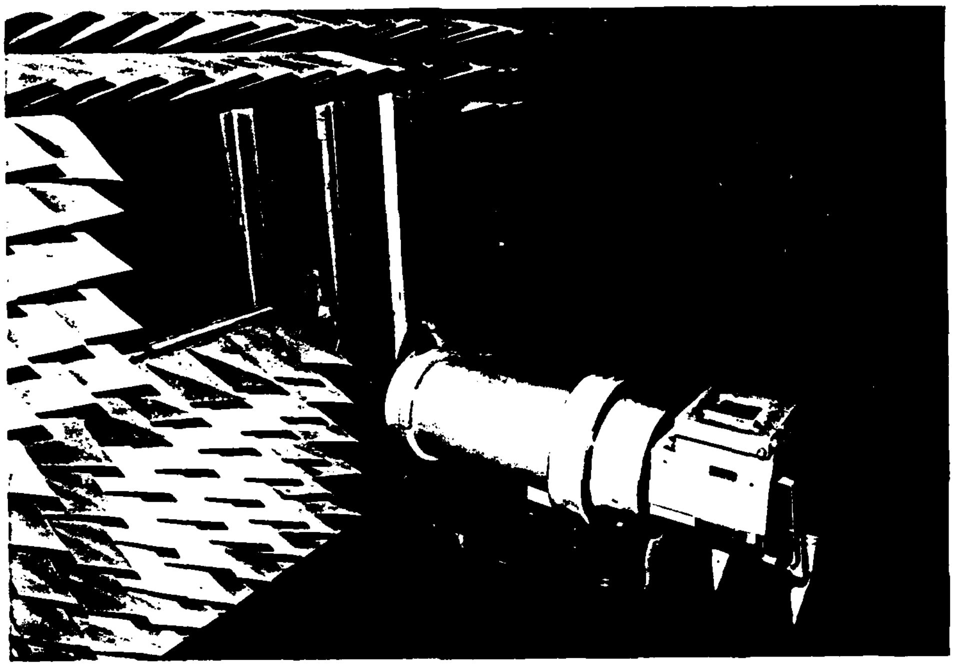


Figure 1. View toward the right rear corner of the anechoic chamber, showing the right sidewall; the "valley" in the Eccowalk floor; the X-ray head passing from behind the false rear wall into the chamber; and the sideways inverted "L" opening in the false rear wall. The moveable support for the X-ray head is seen standing vertically in its horizontal track behind the false wall.

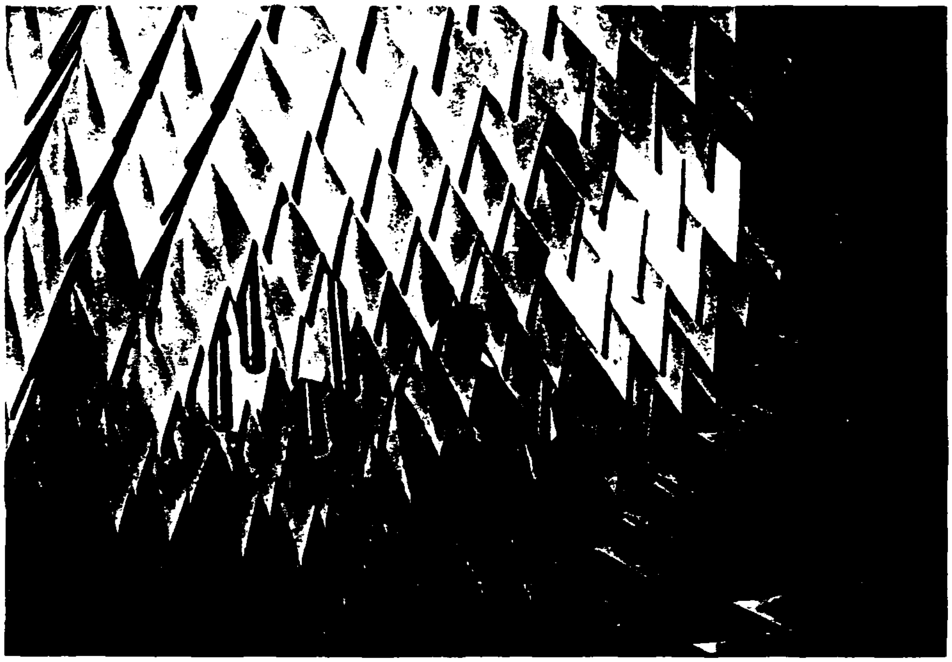


Figure 2. Ceiling at right front corner of anechoic chamber. The brass extensions (with extra cylindrical connections) are located over the X-ray head. Silver SPY-18 Eccosorb cones cover one of the air input ducts; the opening slightly behind this is the light fixture housing. The coaxial cable to the antenna will enter the room from the dark opening on the right.

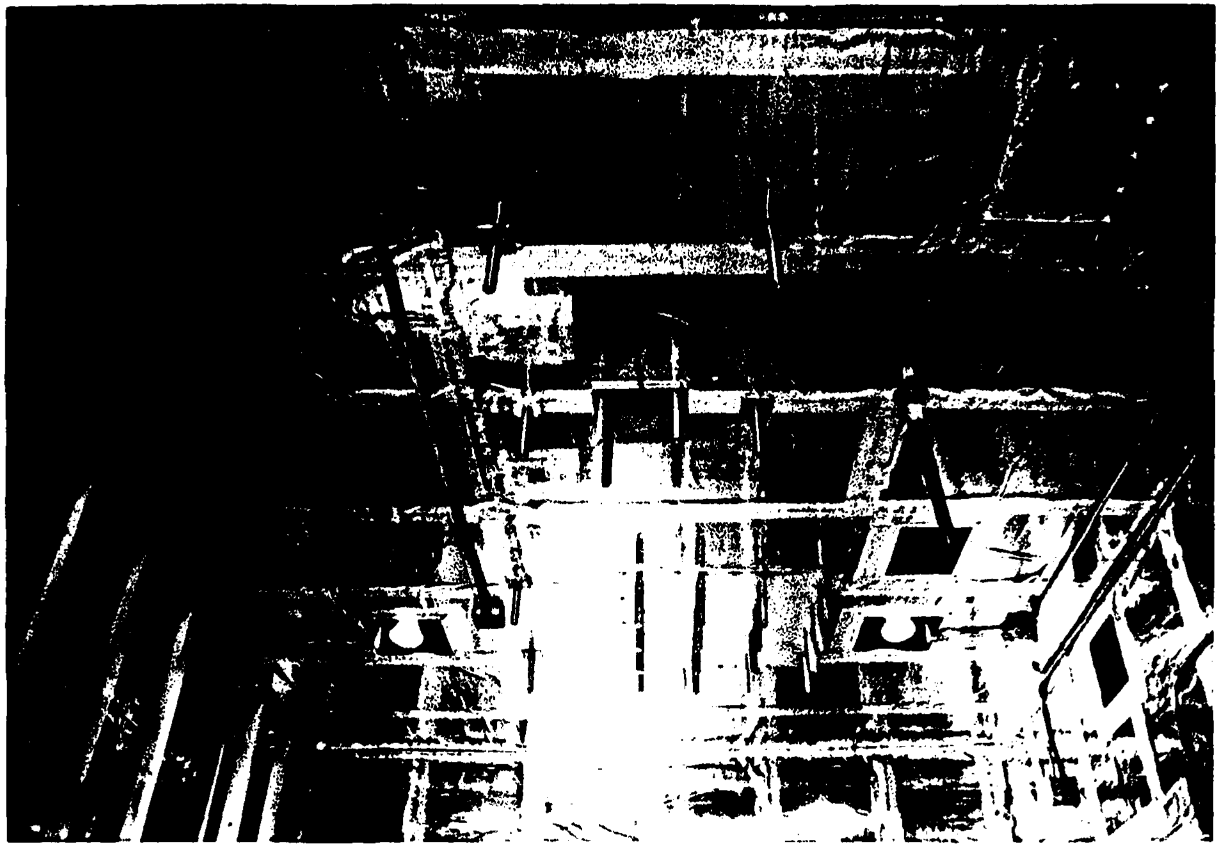


Figure 3. Ceiling of anechoic chamber looking from left to right, with false rear wall being constructed on left. Two air inlet ducts are on ceiling on right (toward front wall), with halon pipe sticking down in between. Recess on top right houses brass plate with connectors for RF cable. Right side and central ceiling mounted brass plates for holding antenna horns are shown, as are light fixtures. Electrical box (toward bottom left) is for one of two smoke detectors.

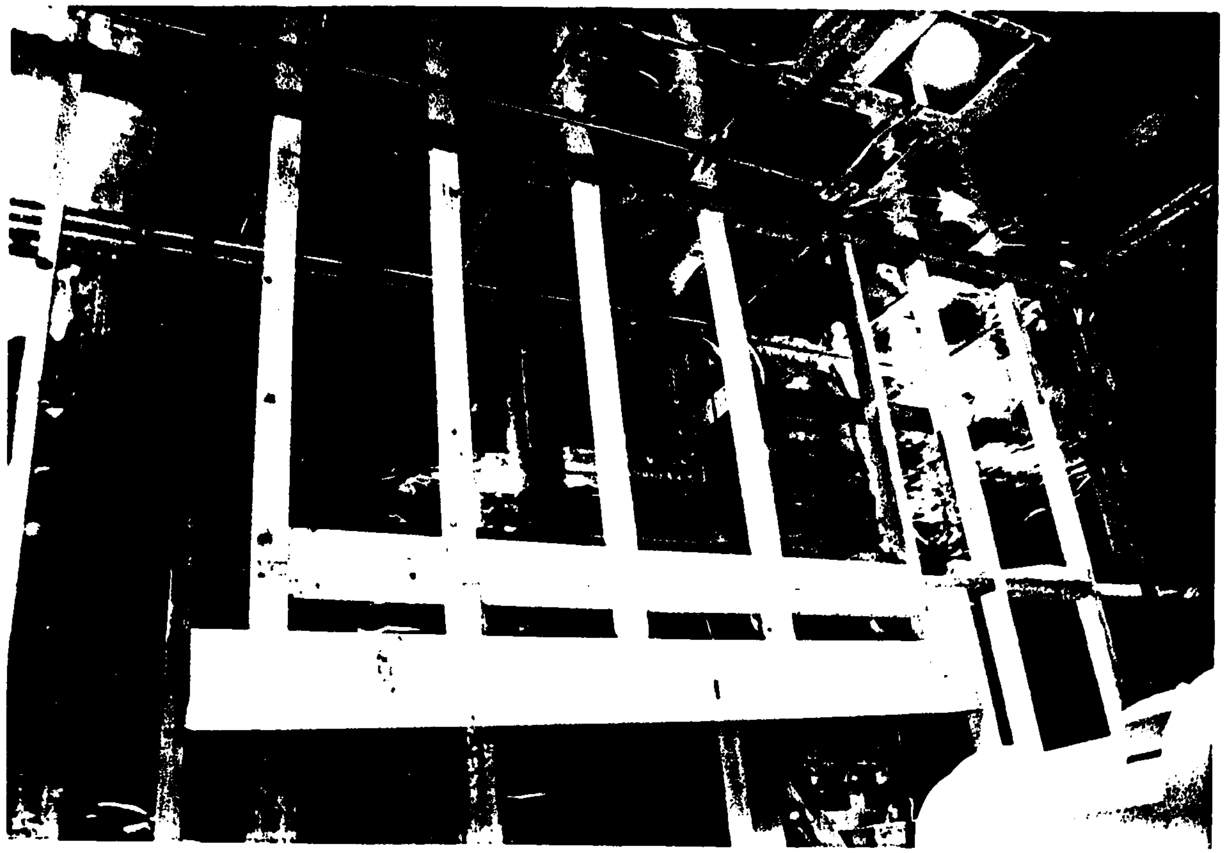


Figure 4. Return air duct in right rear wall behind false wall under construction. Metal track for support of the X-ray unit is visible behind the wooden crossbeams.

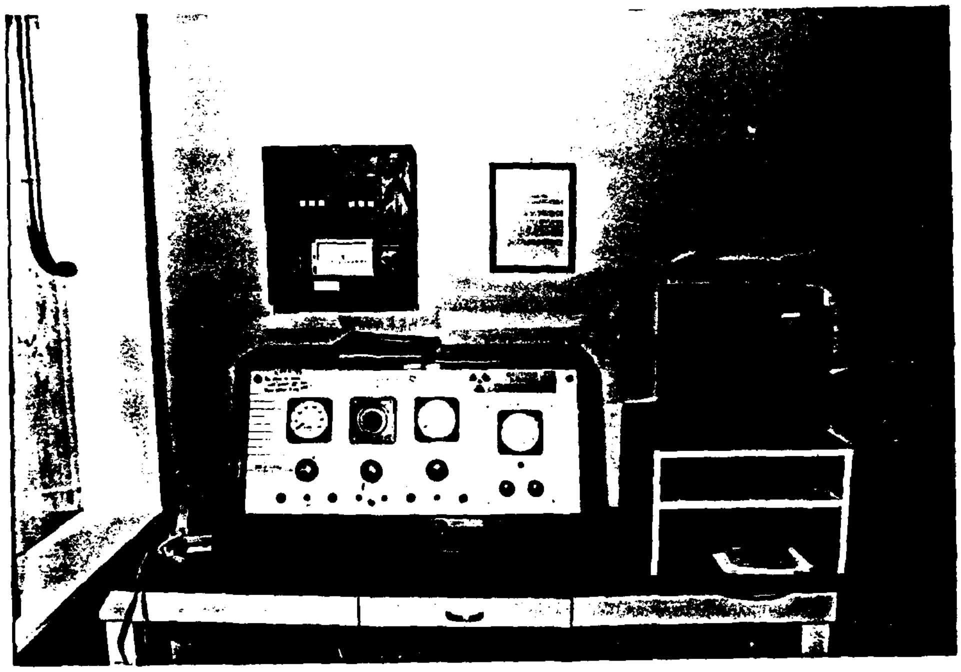


Figure 5. Left sidewall of control room. Temperature and humidity controllers are mounted on wall (with two-track recorder). Also shown are X-ray control panel; monitor for camera with pan and tilt and lens zoom controls beneath it.

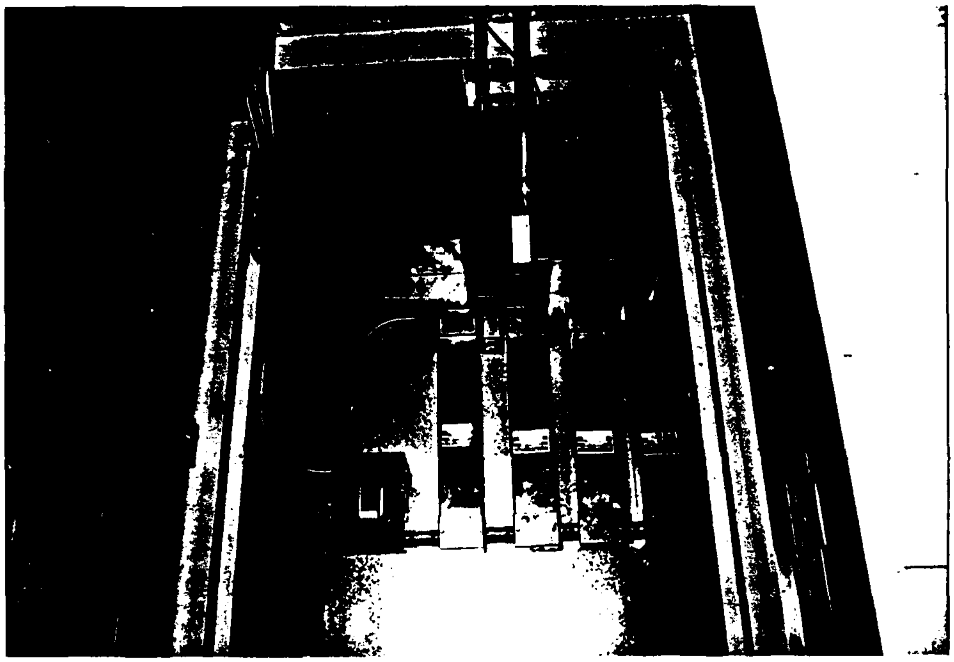


Figure 6. Electrical cabinet in front hallway, looking in from open door. A variety of filter boxes are shown, as is main breaker switch. A brass plate can be seen mounted above the top right filter box, which houses filters for the X-ray unit. All power to the facility, with the exception of a few lines to the X-ray unit from the rear chase, enters through this cabinet.

Figure 7. Control room side of metal panel in electrical cabinet, with temperature and humidity controller mounted on right sidewall.

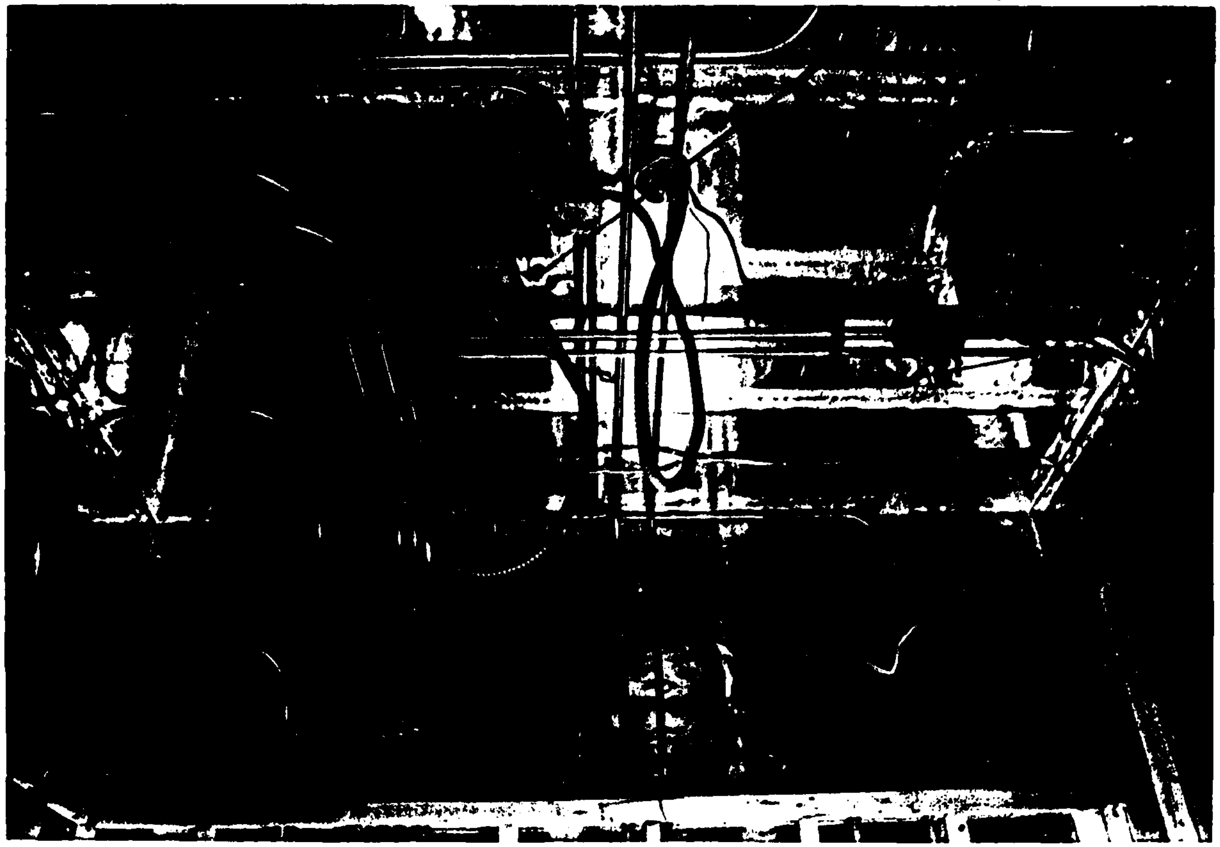


Figure 8. Left ceiling of control room. Penetration for pneumatic tube to humidity controller is shown at lower left above wood frame for drop ceiling. Return air duct is at upper right.

Figure 9. Left rear wall of anechoic chamber showing halon exhaust vent behind false wall. Left upper corner of X-ray support frame is at lower right.

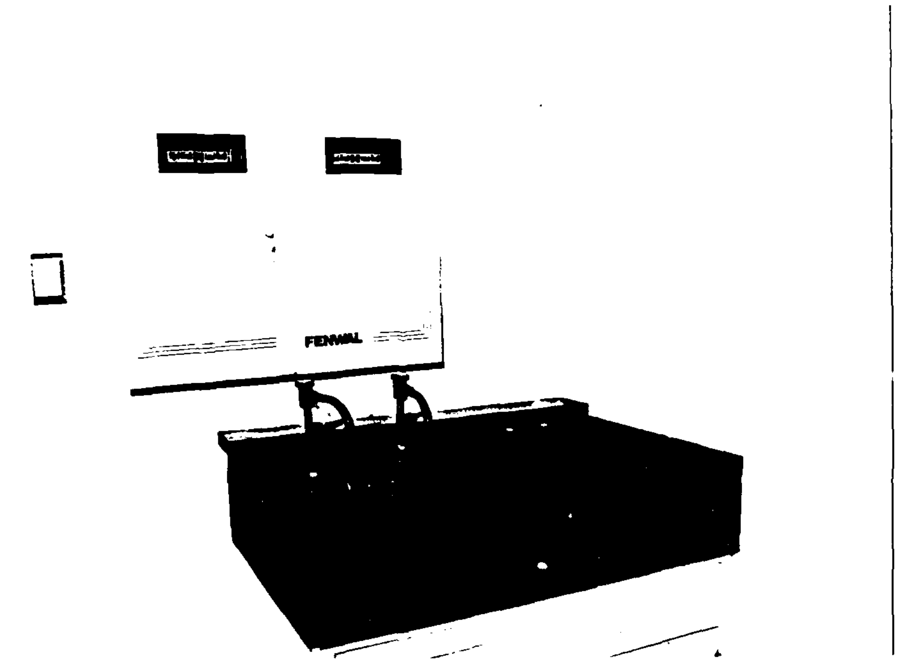


Figure 10. Right sidewall of control room. Halon Fire Suppression system controller is wall mounted above sink. Control room temperature controller is mounted on left.

Figure 11. Left front wall of control room, showing conduits mounted to metal foil shielding on wall and ceiling. The view is above electrical cabinet.

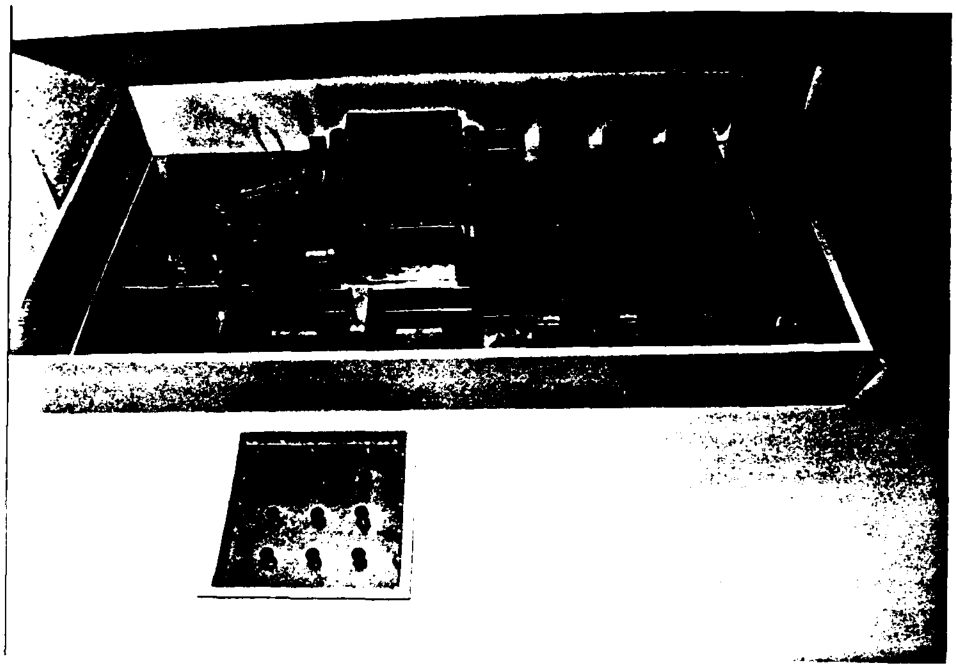


Figure 12. Metal Panel on left rear wall between control room and anechoic chamber. Brass plate with red caps over connectors for RF coaxial cable is beneath panel. Elevated drop ceiling is above panel. The brass capped pipe of larger diameter in the brass plate is for other penetrations when RF shielding is not required.

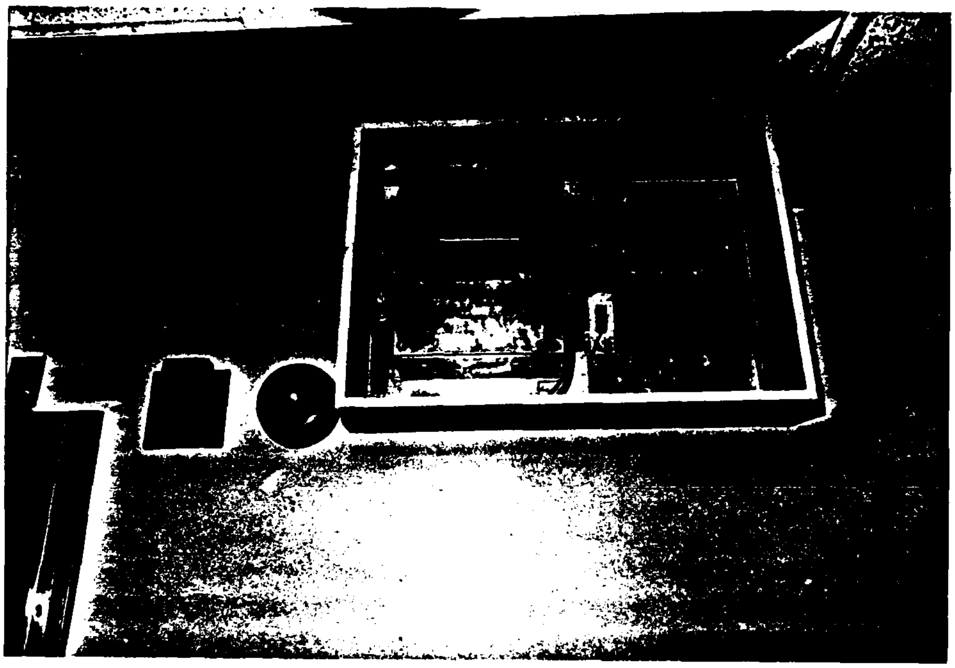


Figure 13. Metal Panel on right rear wall between control room anechoic chamber. Brass plate with BNC connector and video gnal cable, filter box for camera pan and tilt and zoom control ires and brass plate with brass pipes for gas and water lines, can be seen. At middle left, automatic cut-off buttons for X-ray unit and RF transmitter are just visible above the door frame.

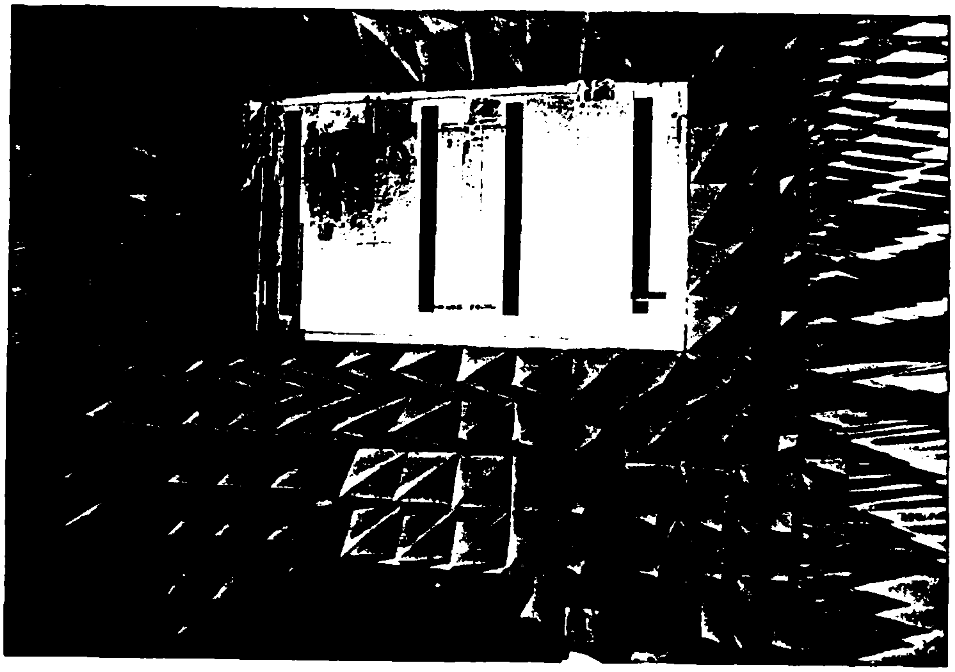
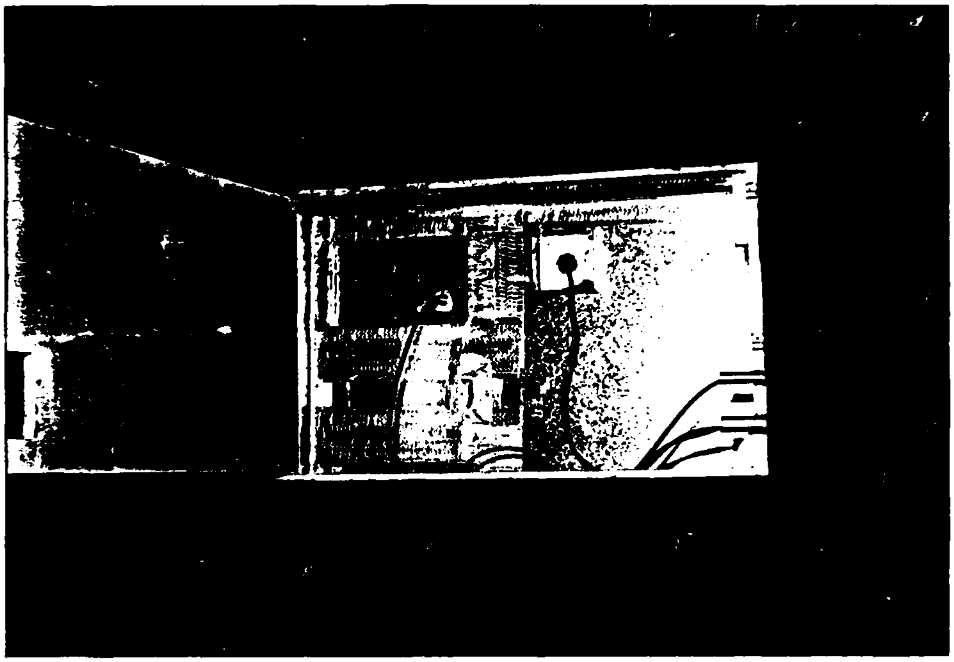


Figure 14. Upper Figure (14a) shows left recess with distribution boxes, etc. Lower Figure (14b) shows closed cabinet, with vertical Velcro strips for mounting Eccosorb panels. Black topped wooden table is shown at bottom. Opening on right will be covered with metal plate for mounting BSD-200 temperature box.



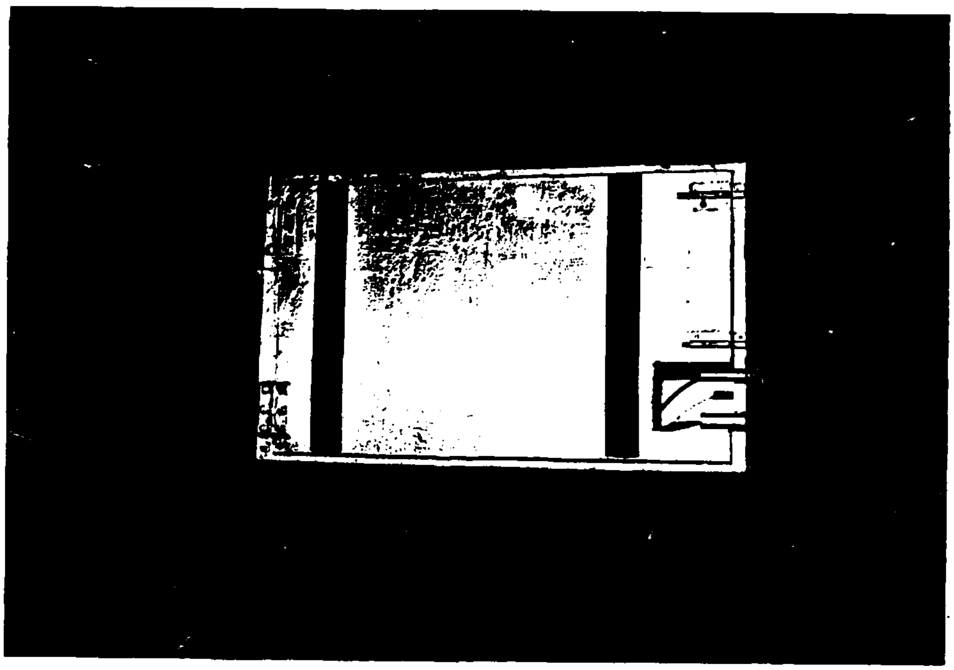


Figure 15. Upper Figure 15a shows right recess. Lower Figure 15b shows closed cabinets, with pan and tilt and zoom control cables coming to it via conduits.

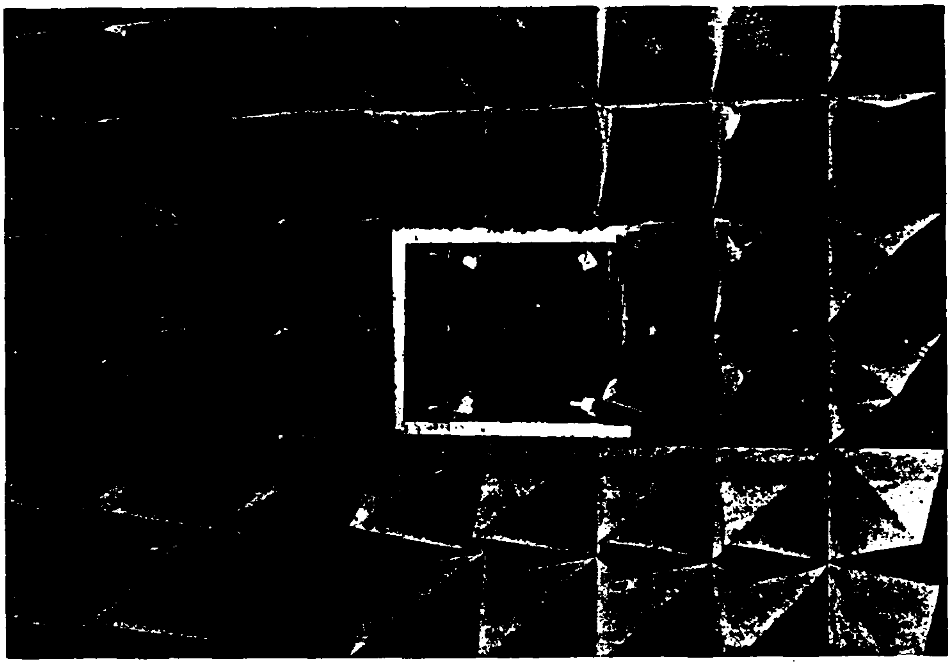


Figure 16. Wall bracket mounted against metal foil in chamber on right front wall for holding BSD-200 Thermometry system temperature box. A similar panel is located on the left side. Unused plate will be covered with Eccosorb.

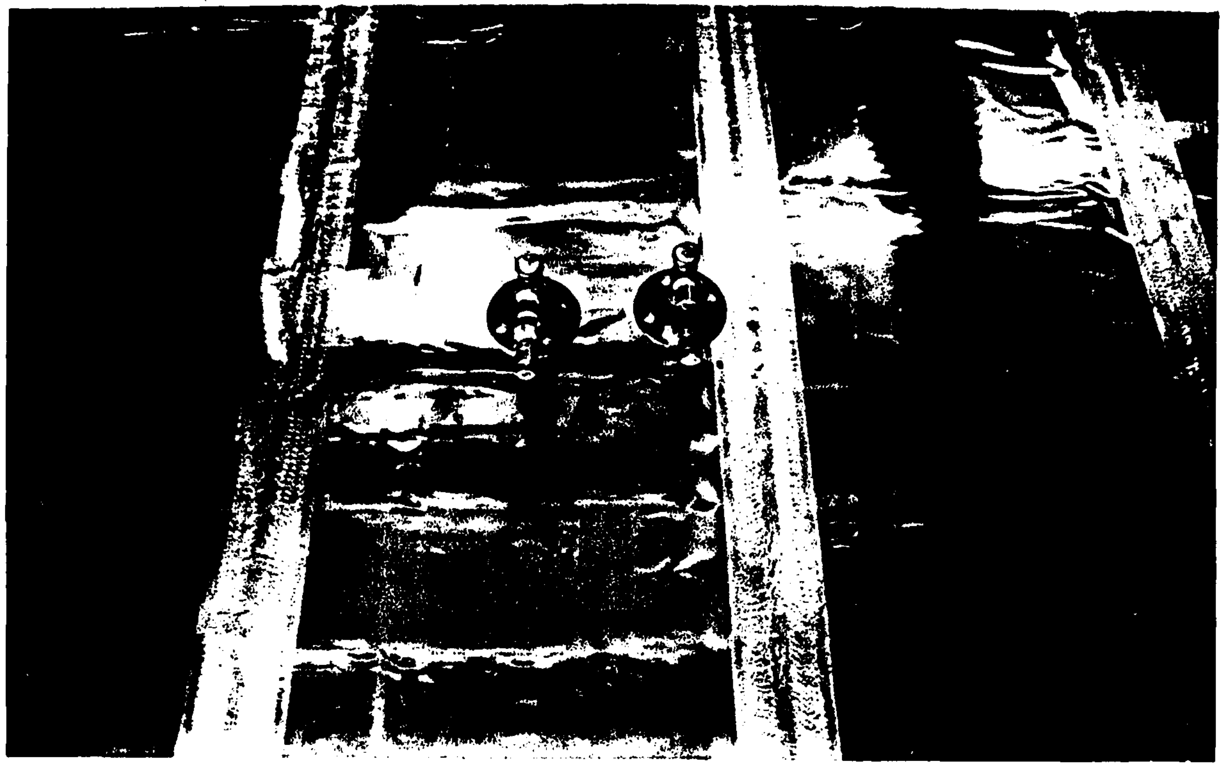


Figure 17. Penetrations for water to and from head of X-ray unit.

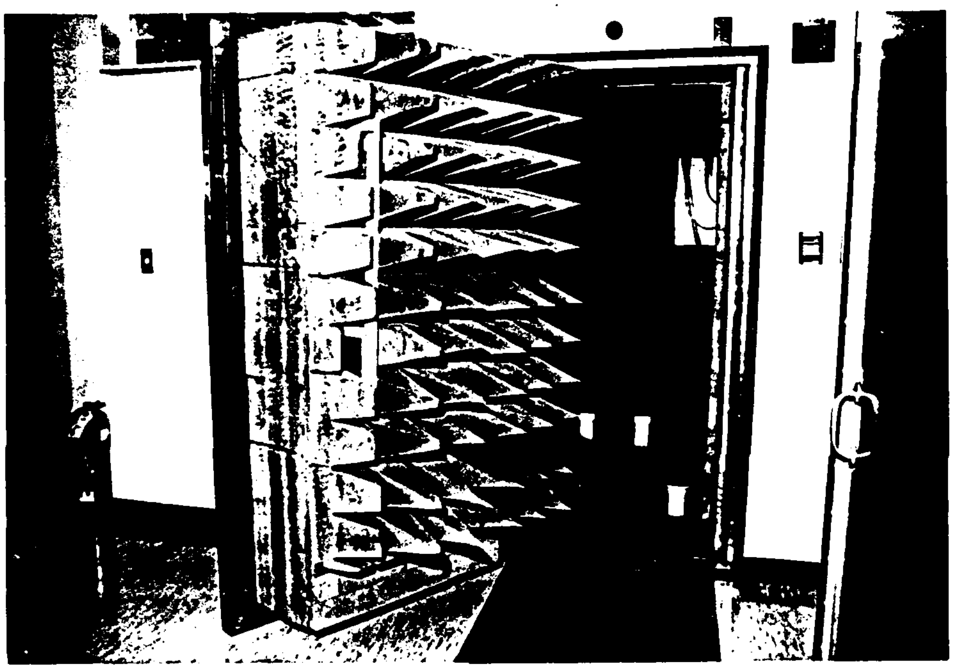


Figure 18. Doorway into anechoic chamber, showing lead-lined door with Eccosorb. Also seen are Eccowalk floor inside chamber, and step leading to it, both supported by PVC piping.

Figure 19. Cohu solid-state color camera mounted above the door leading into the chamber.

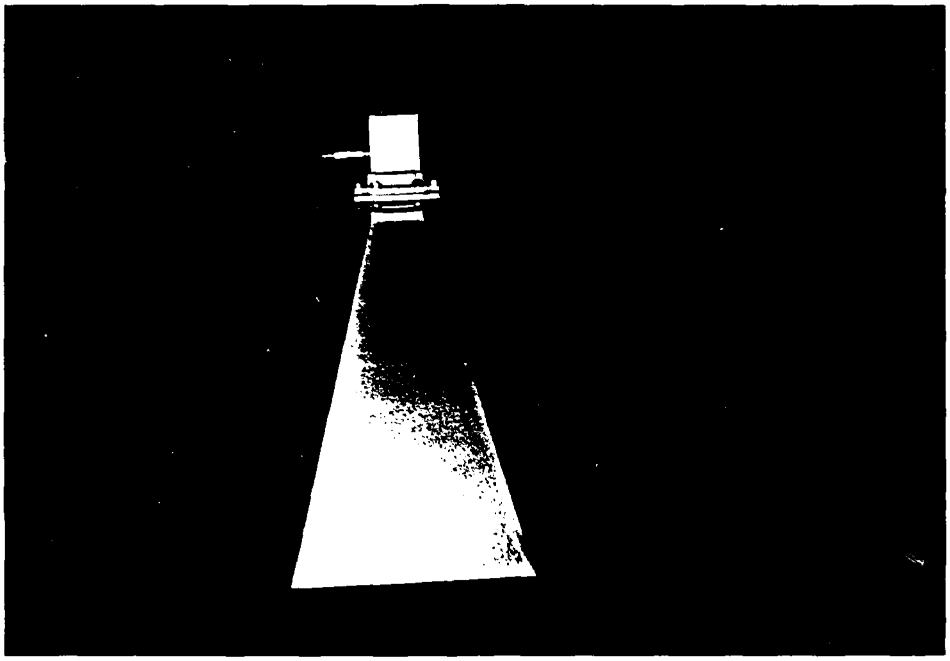


Figure 20. Standard gain antenna horn (2.45 GHz) with attached coax-to-waveguide adapter.

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